The University of Technology, Sydney

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Measurement and Computational Analysis of Skin Conductance Under Repetitive Stimuli and in Different Age Groups

Thesis in Science

By

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Certificate of Originality

'I hereby declare that this submission is my own work and it does not incorporate without acknowledgment any material previously submitted for a degree in any other university; and to the best of my knowledge and belief; it does not contain any material previously published or written by another person, without acknowledgement within the text.

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ABSTRACT

In this work skin conductance measurement was used to investigate a number of aspects of response to repetitive audiovisual stimuli and at different age group subjects. Stimuli were induced with a range of film clips generating emotions and an audiovisual computer generated segment to investigate repetitive stimulation and resultant response. Past skin conductance experimental measurements indicate that a number of specific factors can influence the results. These factors include: electrode type and placement, sensitivity, resolution of the equipment, areas covered by the electrodes, skin temperature and experimental environmental conditions to name just a few.

The electrode placement and recording site used in this work is based on the understanding that maximum neural innervations occur where the ring finger is innervated with both ulnar and median nerves. This was critically important when measured and calculated parameters of skin conductance such as latency, amplitude, response rate and duration of multiple stimulus sequence responses were investigated.

An advanced portable skin conductance device was developed for biomedical application. An audiovisual computer program was prepared for optimisation of the biomedical application and the verification of the results . Repetitive multiple stimuli were introduced sequentially within this video clip that utilised a crashing glass sound to generate excitation. Results were plotted for 21 subjects in two separate experiments using this multiple stimuli. After measuring the skin conductance data, amplitude (intensity), latency (response time, delay), reaction rates (gradient of the rise), and the response length were calculated and statistical analysis carried out.

The results showed that during three repetitive multiple stimulus, after a non action period if a crashing sound was introduced, a decrease in the amplitude of the skin conductance was observed, in contrast the latency or delay in reaction

time was increased with each repetitious stimuli, and the reaction rate for each stimuli was very close for each of the three consecutive crashes.

For the analysis of continuous stimulation, five film segments were used and measured skin conductance parameters were again analysed. A detailed statistical analysis was carried out for one of the film segments and analysis was applied to 59 subjects that were grouped according to their age distribution and grouping. The results showed a good correlation of the groupings and it was determined that with increased age, skin conductance is reduced.

This verification results showed that a reliable audiovisual stimulation may assist with subjects maintaining focus. The results also showed that attention may act as a filter for the response minimizing spontaneous sudomotor reflexes that enable the study of repetitive stimulus of oddball paradigm.

The results validate the effectiveness of the developed device and indicate that under controlled conditions, multiple sequential stimuli might initiate brain-to-skin conductance path might be crucial in controlling responsive psychological stimuli and possibly its clinical applications such as control of epileptic seizure and its use as early seizure warning device.

To understand the brain pathways and the reaction mechanisms of the emotional stimuli, future work utilising this device, with functional magnetic resonance imaging and other classic medical monitoring equipment such as the EEG is recommended.

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ABREVIATIONS

Ach – Acetylcholine

ADC – Analogue to Digital Conversion

ANS – Autonomic Nerves System

BOLD – Blood Oxygenation Level-Dependent

CNS – Central Nervous System

EDA – Electro Dermal Activity

EEG – Electroencephalography

FMRI – Functional Magnetic Resonance Imaging

FPS – Frames Per Second

GSR – Galvanic Skin Response

ITI – Inter Trial Intervals

OR – Orienting Response

PNS – Peripheral Nervous System

PSI – Palmar Sweat Index

SCL – Skin Conductance Level

SCR – Skin Conductance Response

SD – Standard Deviation

SPL – Skin Potential Level

SPR – Skin Potential Response

SRL – Skin Resistance Level

SRR – Skin Resistance Response